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Docket No.: 245494US41X DIV

COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313

RE: Application Serial No.: 10/716,461
Applicants: Francois KUBICA
Filing Date: November 20, 2003
For: METHOD FOR OPERATING AN AIRCRAFT
Group Art Unit: 3661
Examiner: Behncke, C.

SIR:

Attached hereto for filing are the following papers:

APPEAL BRIEF WITH APPENDICES
ATTACHMENT- MISSILE GUIDANCE

Our credit card payment form in the amount of **$500.00** is attached covering any required fees. In the event any variance exists between the amount enclosed and the Patent Office charges for filing the above-noted documents, including any fees required under 37 C.F.R 1.136 for any necessary Extension of Time to make the filing of the attached documents timely, please charge or credit the difference to our Deposit Account No. 15-0030. Further, if these papers are not considered timely filed, then a petition is hereby made under 37 C.F.R. 1.136 for the necessary extension of time. A duplicate copy of this sheet is enclosed.

Respectfully submitted,

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DOCKET NO: 245494US41X DIV

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF	:
FRANCOIS KUBICA	: EXAMINER: BEHNCKE, C.
SERIAL NO: 10/716,461	:
FILED: NOVEMBER 20, 2003	: GROUP ART UNIT: 3661
FOR: METHOD FOR OPERATING AN AIRCRAFT	:

APPEAL BRIEF

COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313

SIR:

This is an appeal from the decision of the Examiner dated April 7, 2006, which finally rejected Claims 1, 3, 7-11, 13, 26, and 28-30 in the above-identified patent application.

I. REAL PARTY-IN-INTEREST

The real part-in-interest is Airbus France S.A.S.

II. RELATED APPEALS AND INTERFERENCES

Appellants, Appellants' legal representative, and the assignees are aware of no appeals which will directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

III. STATUS OF CLAIMS

Claims 1, 3, 7-11, 13, 26, and 28-30 have been finally rejected and form the basis for this appeal. Appendix VIII includes a clean copy of appealed Claims 1, 3, 7-11, 13, 26, and 28-30.

IV. STATUS OF AMENDMENTS

No amendments after final rejection have been filed.

V. SUMMARY OF CLAIMED SUBJECT MATTER

Independent Claim 1 is directed to a method for operating an aircraft. The method includes receiving guidance instructions and guidance parameters at a navigation computer, transmitting automatic pilot instructions from the navigation computer to a flight control computer over a dedicated communication link, and receiving control instructions and the automatic pilot instructions at the flight control computer. The method further includes generating a first plurality of operating commands based on the automatic pilot instructions at the flight control computer when in an automatic pilot mode and generating a second plurality of operating commands based on the control instructions at the flight control computer in a manual pilot mode. This method is described in the specification from page 5, line 25 to page 6, line 17, as illustrated by Figure 3. Navigation computer 9A receives guidance instructions over link 11 and guidance parameters over lines 12. Navigation computer 9A transmits automatic pilot instructions to flight control computer 3 over a dedicated communication link 18. Flight control computer receives the automatic pilot instructions over link 18 and control instructions over lines 4. In an automatic pilot mode, flight control computer 3 generates a first plurality of operating commands based on the

automatic pilot instructions. In a manual pilot mode, flight control computer 3 generates a second plurality of operating commands based on the control instructions.

Independent Claim 13 is directed to a method for operating an aircraft. The method includes transmitting automatic pilot instructions from the navigation computer to a flight control computer over a dedicated communication link and receiving control instructions and the automatic pilot instructions at the flight control computer. The method further includes generating a first plurality of operating commands based on the automatic pilot instructions at the flight control computer when in an automatic pilot mode and generating a second plurality of operating commands based on the control instructions at the flight control computer in a manual pilot mode. This method is described in the specification from page 5, line 25 to page 6, line 17, as illustrated by Figure 3. Navigation computer 9A transmits automatic pilot instructions to flight control computer 3 over a dedicated communication link 18. Flight control computer receives the automatic pilot instructions over link 18 and control instructions over lines 4. In an automatic pilot mode, flight control computer 3 generates a first plurality of operating commands based on the automatic pilot instructions. In a manual pilot mode, flight control computer 3 generates a second plurality of operating commands based on the control instructions.

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The grounds of rejection to be reviewed on appeal are whether Claims 1, 3, 6-13, 16 and 26-30 are unpatentable under 35 U.S.C. §103(a) over Pages (U.S. Patent No. 5,774,818) in view of Trikha (U.S. Patent No. 6,003,811).

VII. ARGUMENTS

A. Introduction

Claim 1 recites, *inter alia*, a method for operating an aircraft comprising:

> receiving guidance instructions and guidance parameters at a navigation computer;
> transmitting automatic pilot instructions from said navigation computer to a flight control computer over a dedicated communication link;
> receiving control instructions and said automatic pilot instructions at said flight control computer;
> in an automatic pilot mode, generating a first plurality of operating commands based on said automatic pilot instructions at said flight control computer; and
> in a manual pilot mode, generating a second plurality of operating commands based on said control instructions at said flight control computer.

Claim 13 recites, *inter alia*, a method for operating an aircraft comprising:

> transmitting automatic pilot instructions from a navigation computer to a flight control computer over a dedicated communication link;
> receiving control instructions and said automatic pilot instructions at said flight control computer;
> in an automatic pilot mode, generating a first plurality of operating commands based on said automatic pilot instructions at said flight control computer; and
> in a manual pilot mode, generating a second plurality of operating commands based on said control instructions at said flight control computer.

B. Claims 1, 3, 7-11, 26, and 28-30 are not unpatentable over Pages in view of Trikha

The outstanding Office Action and the Advisory Action of July 25, 2006 asserted that the description in Pages of the transmittal from computer 12 to automatic piloting device 13 of the position of the next point to be reached is "transmitting automatic pilot instructions from said navigation computer to a flight control computer over a dedicated communication link" as defined in Claim 1.[1] Specifically, the Advisory Action stated that:

[1] See the outstanding Office Action at page 2, lines 17-20.

> Pages teaches that the computer 12 receives pilot entered geographic points and route constraints transferred from device 11; computer route/flight paths based on the received data; transmits to element 13 these computer route/flight paths (figure 4).2

However, it is respectfully submitted that the next point to be reached described in Pages or the "computer route/flight paths" cited in the Advisory Action is at best "guidance instructions" or "guidance parameters," ***not*** "automatic pilot instructions."

As shown in the attached document regarding missile guidance,[3] a desired path is input into a guidance algorithm, where guidance laws are used to calculate guidance commands. The guidance commands are positional commands to move the craft onto the path desired. These guidance commands are input into an autopilot algorithm, which calculates actuator commands based on the guidance commands and the craft response characteristics. These actuator commands are sent to actuators controlling the control surfaces of the craft. As noted in the Advisory Action, the attached document is not dated, but it was never intended to be considered prior art, it is simply provided as an example as what is known in the art.

In the invention recited in Claim 1, the navigation computer receives guidance instructions and guidance parameters and calculates "automatic pilot instructions" (i.e. guidance commands). These "automatic pilot instructions" are sent to the flight control computer, which, in an automatic pilot mode, generates a plurality of "operating commands" (i.e. actuator commands) based on these automatic pilot instructions.

Thus, the generation of the "automatic pilot instructions" (i.e. guidance commands) and the "operating commands" (i.e. actuator commands) is split into two different computers, allowing faster calculation of these two different sets of parameters.

[2]The Advisory Action dates July 25, 2006, page 2, lines 7-9.
[3]http://www.aerospaceweb.org/question/weapons/q0187.shtml

In contrast, Pages describes calculation of ***both*** the guidance commands and the autopilot commands in automatic piloting device 13. This is clear because Pages describes that guidance parameters (i.e. the position and route of the next point to be reached) are provided to automatic piloting device 13, which then calculates the actuator commands to be sent to the control actuators 14. Thus, the automatic piloting device 13 of Pages is burdened with calculating both the guidance commands and the autopilot commands of the critical path calculations. Thus, Pages does not teach or suggest transmitting "automatic pilot instructions" (i.e. guidance commands) from one computer to another, much less transmitting automatic pilot instructions over a dedicated communication link. Consequently, Pages does not teach or suggest "transmitting ***automatic pilot instructions*** over a dedicated communication link" as recited in Claim 1.

Trikha describes a flight control system where autopilot 25 sends flight path change commands to flight computer 26 over a data bus 22.[4] As data bus 22 is ***not*** a dedicated communication link, Trikha also does not teach or suggest "transmitting automatic pilot instructions from said navigation computer to a flight control computer over a ***dedicated communication link***." As neither Pages nor Trikha teaches or suggests "transmitting automatic pilot instructions" as recited in Claim 1, Claim 1 (and Claims 3, 7-11, 26, and 28-30 dependent therefrom) is patentable over Pages in view of Trikha.

Claim 13 recites similar elements to Claim 1. Accordingly, Claim 13 is patentable over Pages in view of Trikha for at least the reasons described above with respect to Claim 1.

B. Claims 9-11 further define over Pages in view of Trikha

Claim 9 recites in part, "wherein said automatic pilot instructions and said control instructions correspond to a commanded vertical load factor."

[4] See Trikha, column 3, lines 18-20 and Figure 1.

Claim 10 recites in part, "wherein said automatic pilot instructions and said control instructions correspond to a commanded roll rate."

Claim 11 recites in part, "wherein said automatic pilot instructions and said control instructions correspond to a commanded yaw."

The outstanding Office Action asserted that:

> Pages and Trikha teach the transmitted automatic/control instructions include desired change in the aircraft's flight path (Pages: Column 5, lines 43-46; Trikha, Column 3, lines 7-24). It is well known in the art that the parameters corresponding to a vertical load factor, roll rate, and yaw are specifically used to designate and change the flight path.[5]

Even assuming *arguendo* that a vertical load factor, a commanded roll rate, and a commanded yaw command are known in the art as ***guidance commands***, the invention recited in Claim 1 ***transmits*** these parameters from the navigation computer to a flight control computer over ***a dedicated communication link***. It is respectfully submitted that neither Pages nor Trikha teach or suggest transmitting any of a vertical load factor, a commanded roll rate, or a commanded yaw ***from one computer to another over a dedicated communication link***.

As noted above, the automatic piloting device 13 of Pages calculates ***both*** the guidance commands and the autopilot commands. Thus, even assuming *arguendo* that automatic piloting device 13 of Pages computes a vertical load factor, a commanded roll rate, or a commanded yaw, ***no*** computer in Pages transmits or receives any of these parameters, as they remain in automatic piloting device 13 of Pages.

With regard to Trikha, even assuming *arguendo* that autopilot 25 sends a vertical load factor, a commanded roll rate, or a commanded yaw to flight computer 26 over a data bus 22, data bus 22 is not a ***dedicated communication link***.

[5]The Office Action dated April 7, 2006, page 4, lines 16-21.

Thus, neither Pages nor Trikha teaches or suggests the subject matter of any of Claims 9-11. Accordingly, Claims 9-11 further define over Pages in view of Trikha.

Conclusion

It is respectfully requested that the outstanding rejections be REVERSED.

Respectfully submitted,

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VIII. CLAIMS APPENDIX

Claim 1: A method for operating an aircraft, comprising the steps of:

receiving guidance instructions and guidance parameters at a navigation computer;

transmitting automatic pilot instructions from said navigation computer to a flight control computer over a dedicated communication link;

receiving control instructions and said automatic pilot instructions at said flight control computer;

in an automatic pilot mode, generating a first plurality of operating commands based on said automatic pilot instructions at said flight control computer; and

in a manual pilot mode, generating a second plurality of operating commands based on said control instructions at said flight control computer.

Claim 2 (Canceled).

Claim 3: The method of Claim 1, further comprising the step of receiving control parameters at said flight control computer.

Claims 4-6 (Canceled).

Claim 7: The method of Claim 1, further comprising the step of generating said automatic pilot instructions at said navigation computer based on said guidance instructions and on said guidance parameters.

Claim 8: The method of Claim 7, wherein said automatic pilot instructions

correspond in nature to said control instructions.

Claim 9: The method of Claim 8, wherein said automatic pilot instructions and said control instructions correspond to a commanded vertical load factor.

Claim 10: The method of Claim 8, wherein said automatic pilot instructions and said control instructions correspond to a commanded roll rate.

Claim 11: The method of Claim 8, wherein said automatic pilot instructions and said control instructions correspond to a commanded yaw.

Claim 12 (Canceled).

Claims 13: A method for operating an aircraft, comprising the steps of:

transmitting automatic pilot instructions from a navigation computer to a flight control computer over a dedicated communication link;

receiving control instructions and said automatic pilot instructions at said flight control computer;

in an automatic pilot mode, generating a first plurality of operating commands based on said automatic pilot instructions at said flight control computer; and

in a manual pilot mode, generating a second plurality of operating commands based on said control instructions at said flight control computer.

Claims 14-25 (Canceled).

Claim 26: The method of Claim 3, wherein the step of receiving control parameters at said flight control computer comprises receiving said control parameters via an input different from both an input through which said control instructions are received and an input through which said automatic pilot instructions are received.

Claim 27 (Canceled).

Claim 28: The method of Claim 1, further comprising the step of transmitting said first plurality of operating commands from said flight control computer to a plurality of control surfaces.

Claim 29: The method of Claim 28, further comprising the step of receiving inertial information at said navigation computer.

Claim 30: The method of Claim 29, wherein a delay between a time at which said inertial information is received at said navigation computer and a time at which said first plurality of operating commands is transmitted from said flight control computer to said plurality of control surfaces is minimized.

X. RELATED PROCEEDINGS APPENDIX

None.

IX. EVIDENCE APPENDIX

The enclosed portion of www.aerospaceweb.org/question/weapons/q0187.shtml was cited by the applicant in the response filed July 7, 2006.

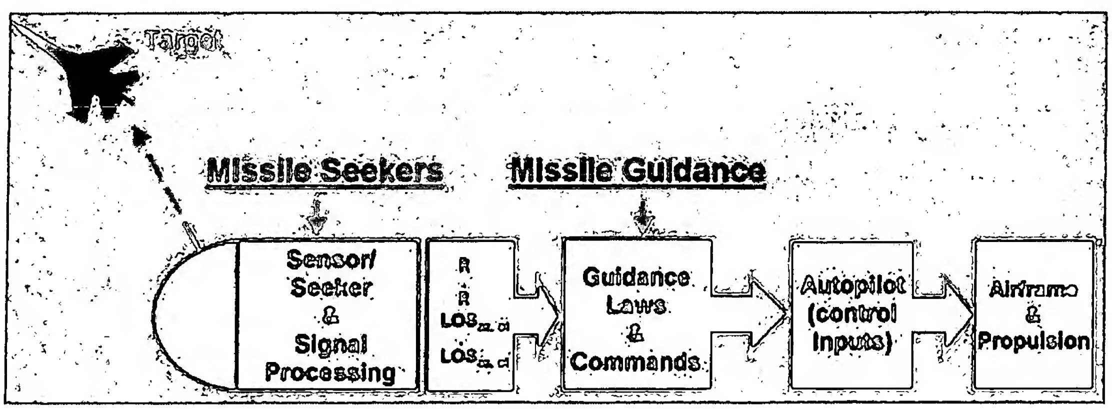
ATTACHMENT
Serial No.: 10/716,461

Missile Guidance

Can you explain the types of guidance systems used in missiles?
- Aftab

Many questioners often seem "concerned" about how missiles are able to seek out and accurately navigate their way to the correct target without assistance from a human operator. However, there is no need for alarm because a weapon very rarely makes a mistake unless it is misprogrammed by the human who launches it in the first place. In fact, many of the methods used for missile guidance are the same as those used to navigate manned planes like the commercial airliners you and I fly aboard.

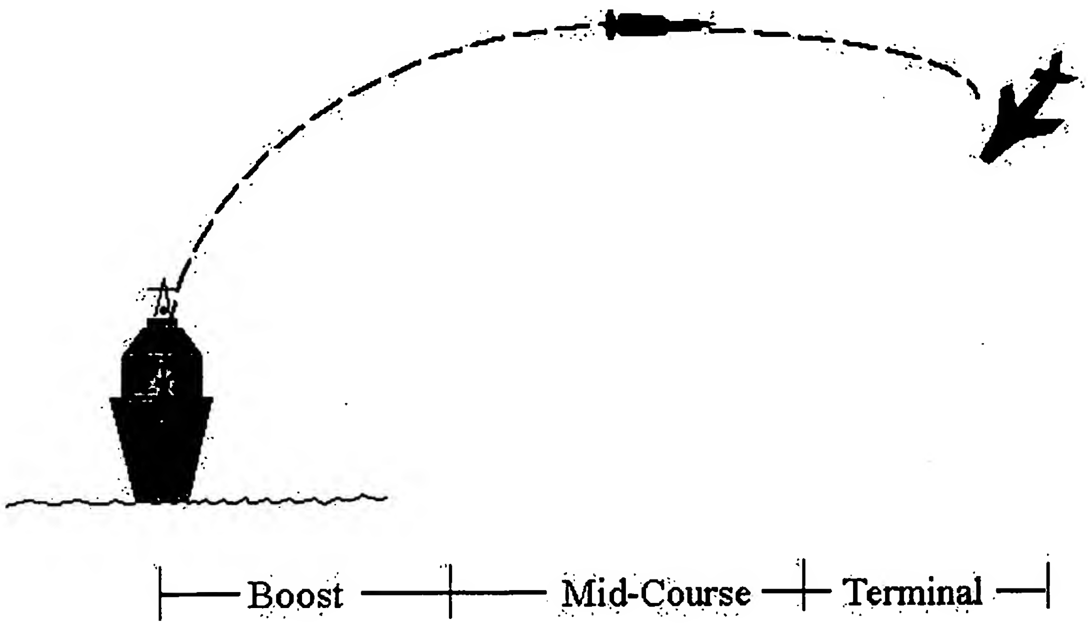
The first topic we need to address is establishing some basic definitions. Missiles can be categorized in many different ways, such as by their mission or lauch platform. The two conventions we will follow in this article concern the missile's type of guidance and type of sensor or seeker. These two concepts are often used interchangeably, but it is important to understand their differences.



Concept of missile guidance

Missile guidance concerns the method by which the missile receives its commands to move along a certain path to reach a target. On some missiles, these commands are generated internally by the missile computer autopilot. On others, the commands are transmitted to the missile by some external source. The missile sensor or seeker, on the other hand, is a component within a missile that generates data fed into the missile computer. This data is processed by the computer and used to generate guidance commands. Sensor types

commonly used today include infrared, radar, and the global positioning system. Based on the relative position between the missile and the target at any given point in flight, the computer autopilot sends commands to the control surfaces to adjust the missile's course.



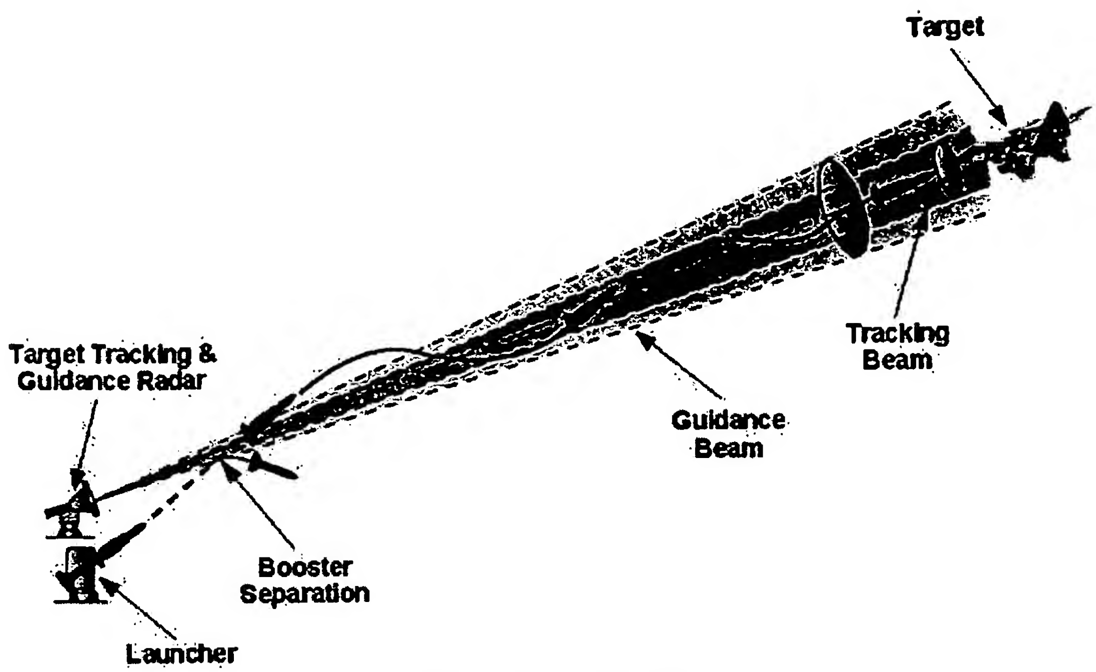
Phases of missile guidance

In many missiles, the guidance system is divided into three phases, as pictured above. The first is a launch or boost phase in which the guidance system is usually disabled to allow the missile to safely travel away from the launch platform. The majority of the flight is flown using midcourse guidance, during which the missile makes slight adjustments to its trajectory allowing it to reach the vicinity of the target. The final phase is terminal guidance when the missile uses a highly accurate tracking system to make rapid maneuvers for intercepting the target. Many missiles use a different type of guidance in the midcourse phase than in the terminal phase, as will be discussed later.

The primary forms of missile guidance are described below with examples of missiles and seekers used to accomplish that type of guidance.

Beam Rider Guidance

The beam rider concept relies on an external ground- or ship-based radar station that transmits a beam of radar energy towards the target. The surface radar tracks the target and also transmits a guidance beam that adjusts its angle as the target moves across the sky.



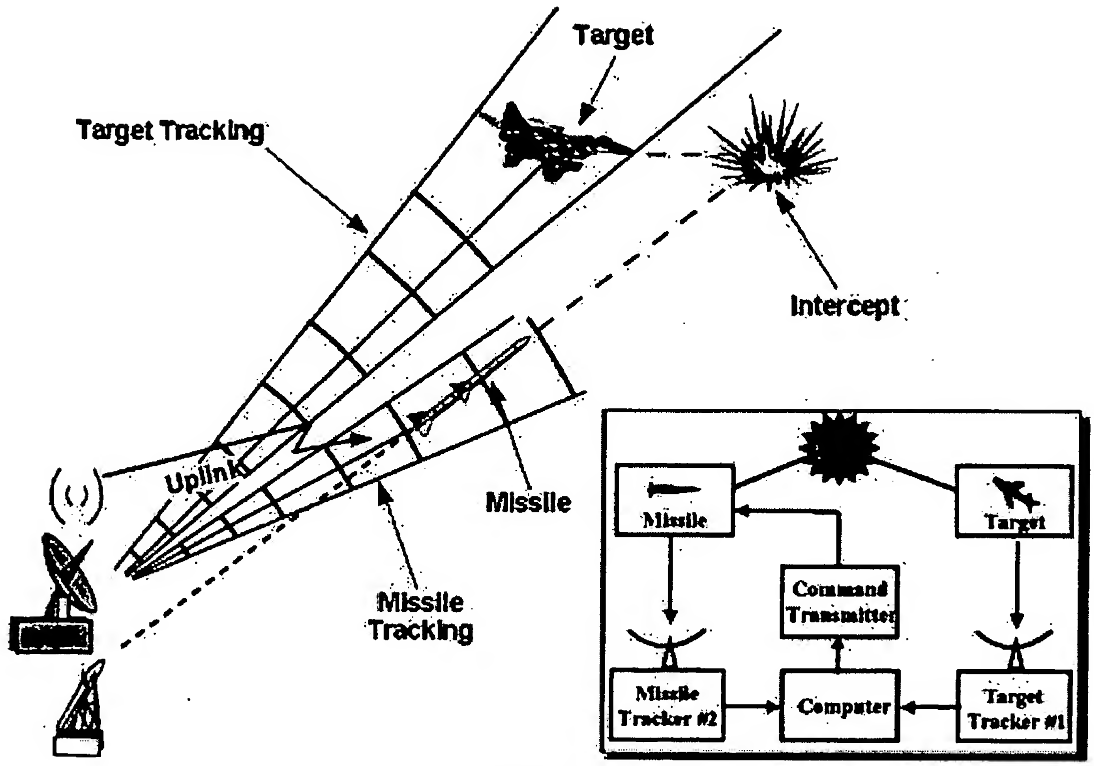
Beam rider guidance

The missile is launched into this guidance beam and uses it for direction. Scanning systems onboard the missile detect the presence of the beam and determine how close the missile is to the edges of it. This information is used to send command signals to control surfaces to keep the missile within the beam. In this way, the missile "rides" the external radar beam to the target.

Beam riding was often used on early surface-to-air missiles but was found to become inaccurate at long ranges. Limited improvement was possible using two different surface-based radar beams, but the beam rider method has been largely abandoned. The technique was used on the US Navy's Terrier ship-launched surface-to-air missile of the 1950s.

Command Guidance

Command guidance is similar to beam riding in that the target is tracked by an external radar. However, a second radar also tracks the missile itself. The tracking data from both radars are fed into a ground based computer that calculates the paths of the two vehicles.



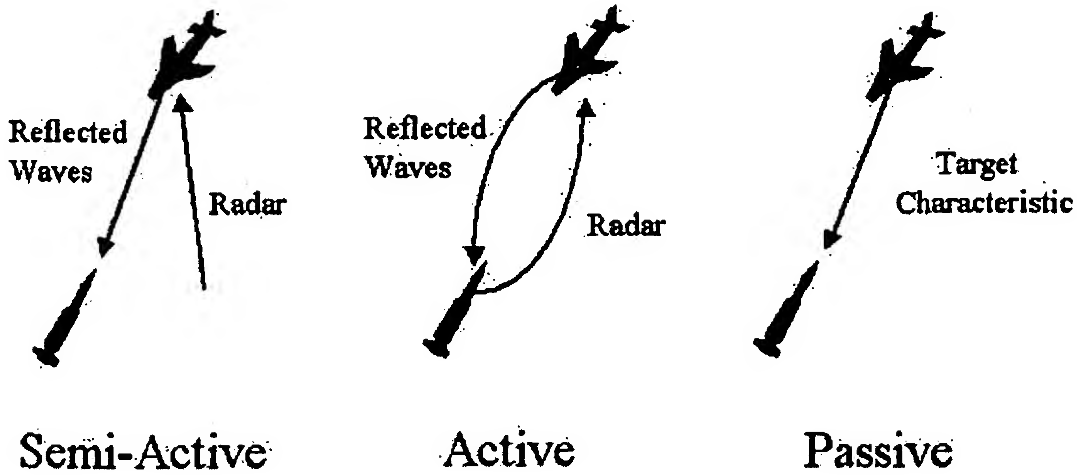
Command guidance

This computer also determines what commands need to be sent to the missile control surfaces to steer the missile on an intercept course with the target. These commands are transmitted to a receiver on the missile allowing the missile to adjust its course. An example of command guidance is the Russian SA-2 surface-to-air missile used against US aircraft in North Vietnam.

Also note that command guidance is not limited just to radar. Another method that falls under command guidance is the use of wire guided systems. In this technique, commands are sent to the missile through a conventional wire or fiber optic cable that reels out from the missile back to its launcher. Wire guidance is often used on anti-tank missiles like TOW, which can be launched from both ground vehicles and helicopters. Many naval torpedoes fired from submarines also use wire guidance.

HOMING GUIDANCE

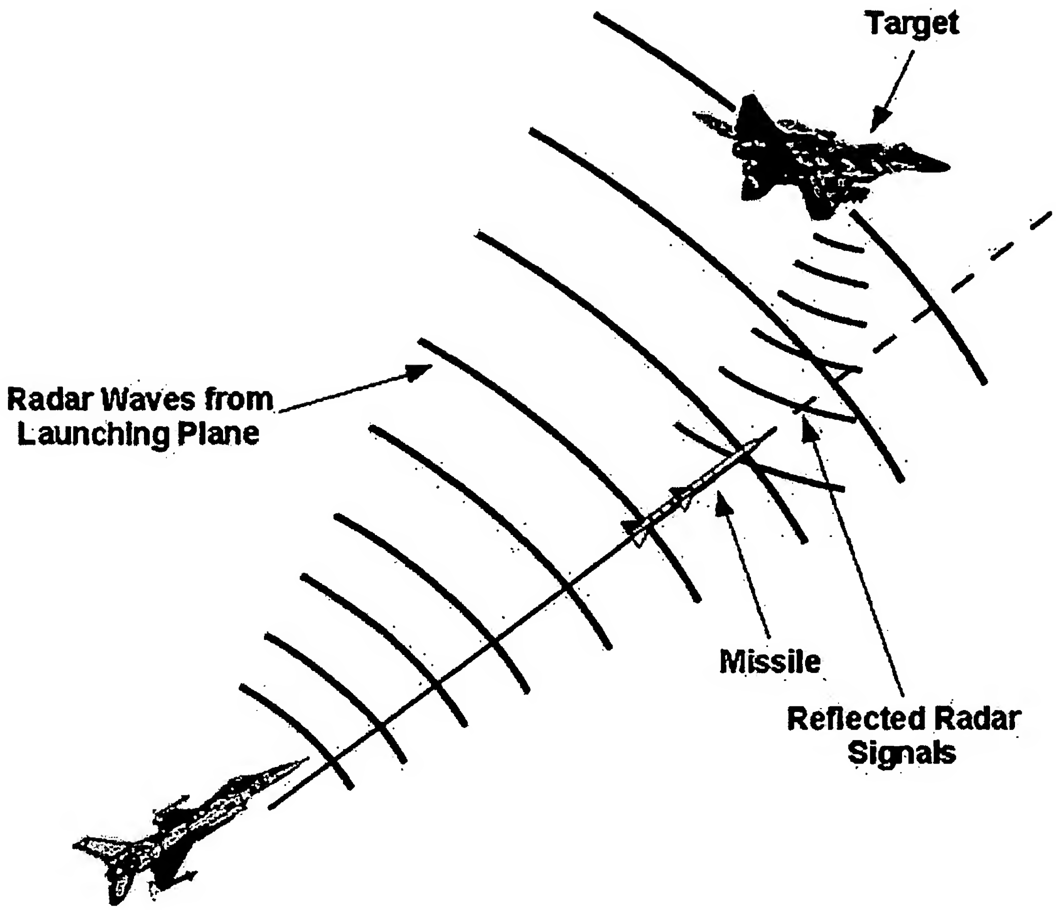
Homing guidance is the most common form of guidance used in anti-air missiles today. Three primary forms of guidance fall under the homing guidance umbrella--semi active, active, and passive. We will discuss each of these in turn, as well as a more unusual form called retransmission or track-via-missile homing.



Homing guidance

Semi-Active Homing Guidance

A semi-active system is similar to command guidance since the missile relies on an external source to illuminate the target. The energy reflected by this target is intercepted by a receiver on the missile. The difference between command guidance and semi-active homing is that the missile has an onboard computer in this case. The computer uses the energy collected by its radar receiver to determine the target's relative trajectory and send correcting commands to control surfaces so that the missile will intercept the target.



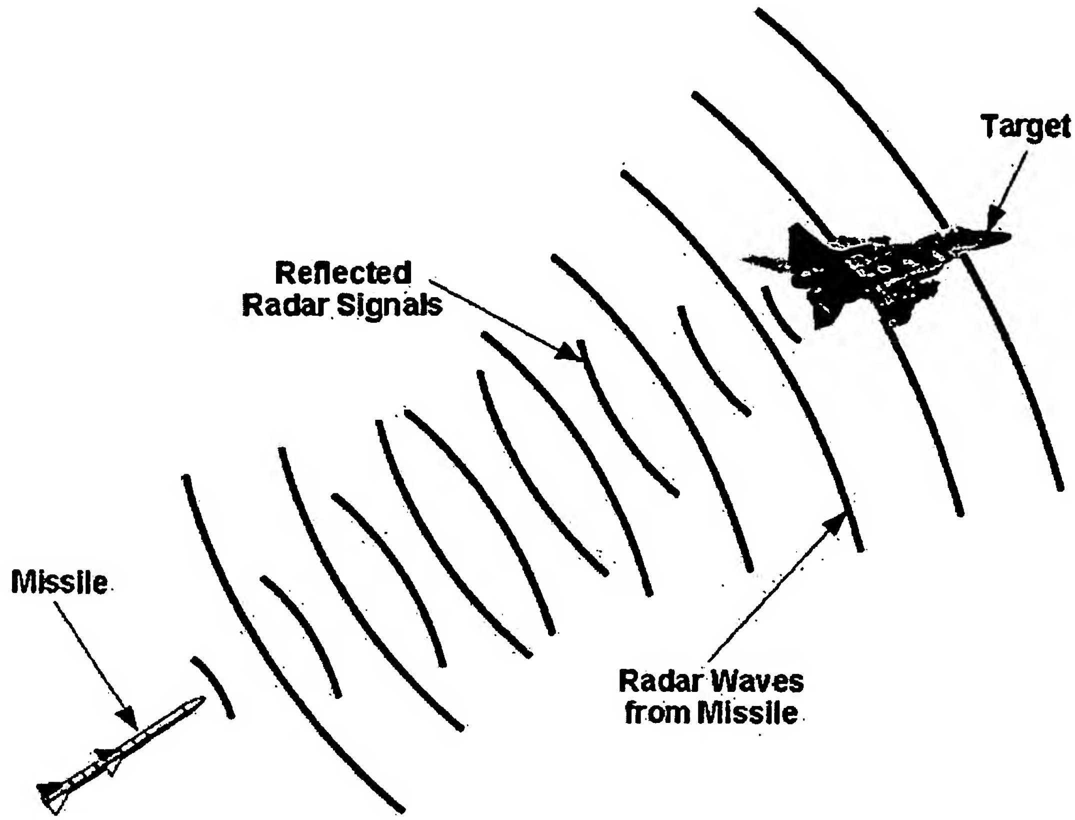
Semi-active homing guidance

The example shown above illustrates the guidance method used on an air-to-air missile like Sparrow. This missile relies on radar energy transmitted by the launch aircraft to track and home in on the target. This system is also sometimes referred to as bistatic meaning that the radar waves that intercept the target and those reflected back to the missile are at different angles to one another.

However, it should be noted that semi-active guidance is used by other types of seekers besides radar. Laser-guided weapons like the Paveway series can also be considered semi-active weapons because the laser energy these bombs track as they steer towards a target is supplied by an external source. The source could be a laser designation pod on the launch aircraft, on a second aircraft, or aimed by a soldier on the ground.

Active Homing Guidance

Active homing works just like semi-active except that the tracking energy is now both transmitted by and received by the missile itself. No external source is needed. It is for this reason that active homing missiles are often called "fire-and-forget" because the launch aircraft does not need to continue illuminating the target after the missile is launched.

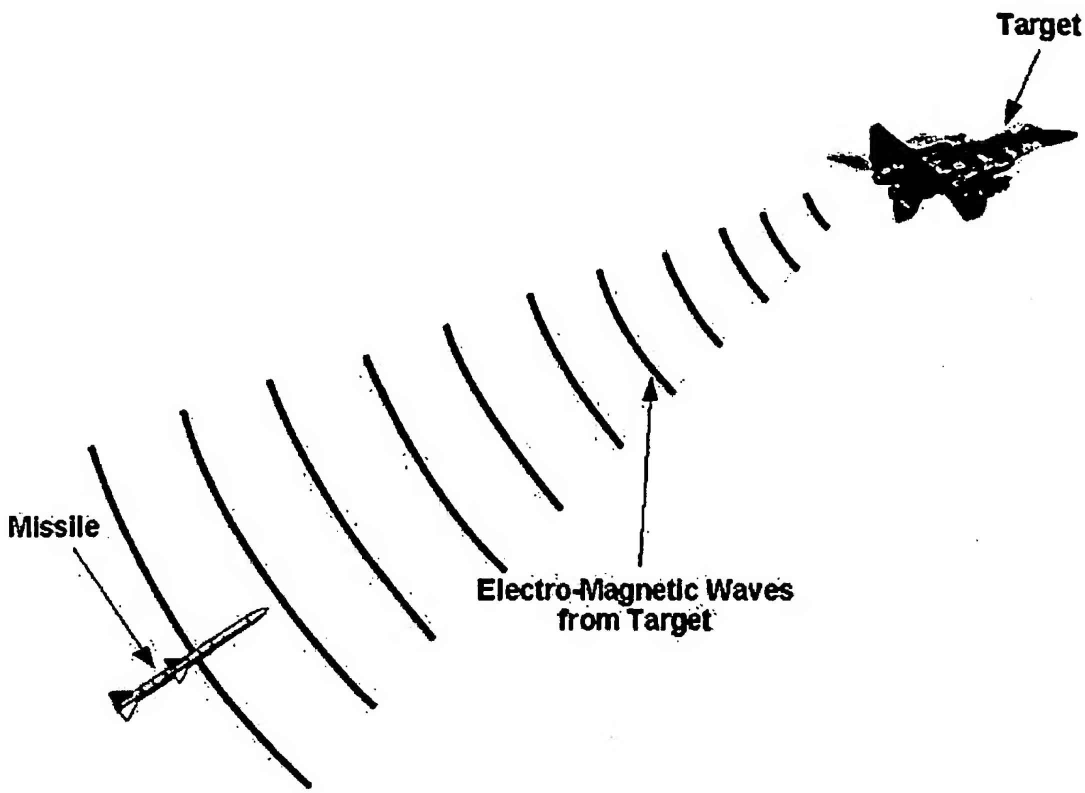


Active homing guidance

Active homing missiles typically use radar seekers to track their target. These seekers are also sometimes called monostatic because, unlike semi-active guidance, the transmitted and reflected waves are at the same angle with respect to the line of sight between the missile and target. Examples of active homing missiles include the AMRAAM air-to-air and Exocet anti-ship missiles.

Passive Homing Guidance

A passive homing system is like active in that the missile is independent of any external guidance system and like semi-active in that it only receives signals and cannot transmit. Passive missiles instead rely on some form of energy that is transmitted by the target and can be tracked by the missile seeker.

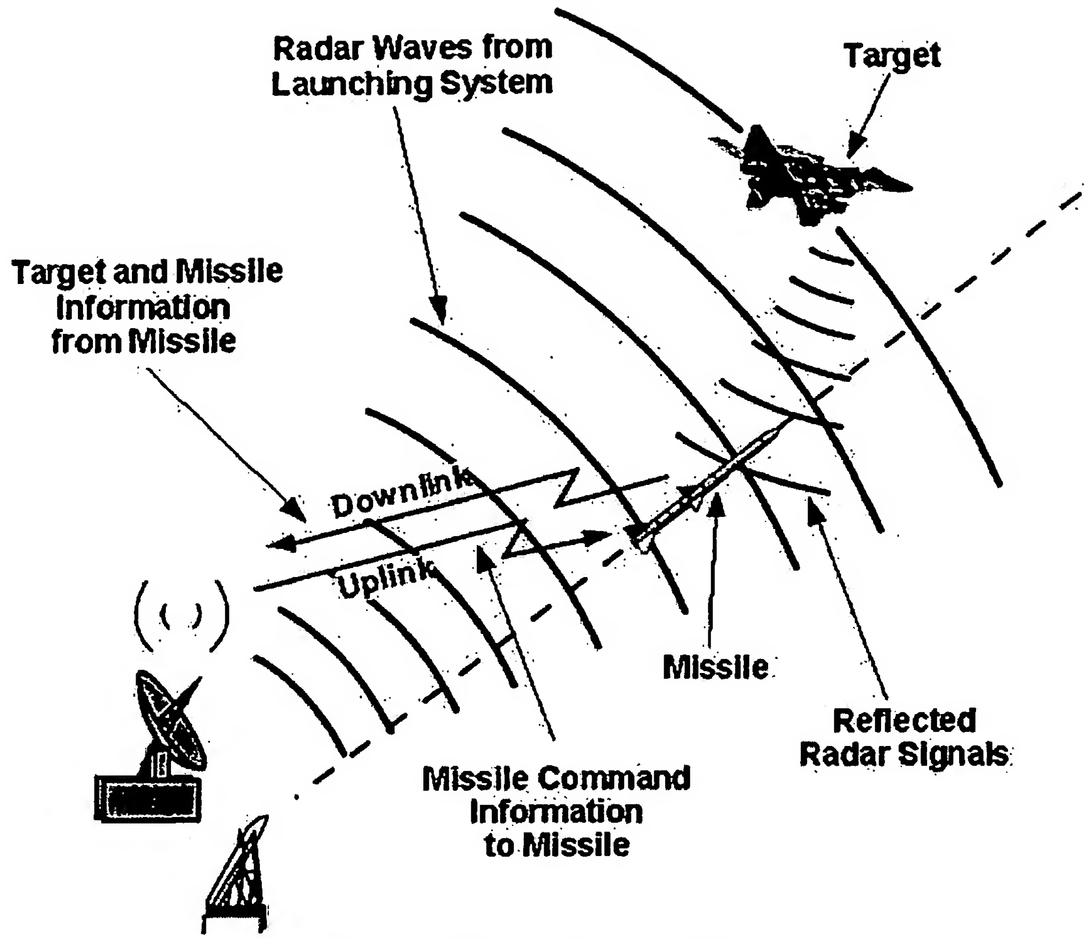


Passive homing guidance

This energy could take many forms. For example, infrared seekers like those used on Sidewinder home in on the heat signature generated by a target. Anti-radiation missiles like HARM track the radio frequency energy transmitted by ground-based radar stations. Passive torpedoes use sonar, or sound waves, created by the engines of ships to attack their targets. Electro-optic sensors like those used on Maverick rely on visual images to guide towards a target.

Retransmission Homing Guidance

A more unusual example of homing guidance is the retransmission method. This technique is largely similar to command guidance but with a unique twist. The target is tracked via an external radar, but the reflected signal is intercepted by a receiver onboard the missile, as in semi-active homing. However, the missile has no onboard computer to process these signals. The signals are instead transmitted back to the launch platform for processing. The subsequent commands are then retransmitted back to the missile so that it can deflect control surfaces to adjust its trajectory.



Retransmission homing guidance

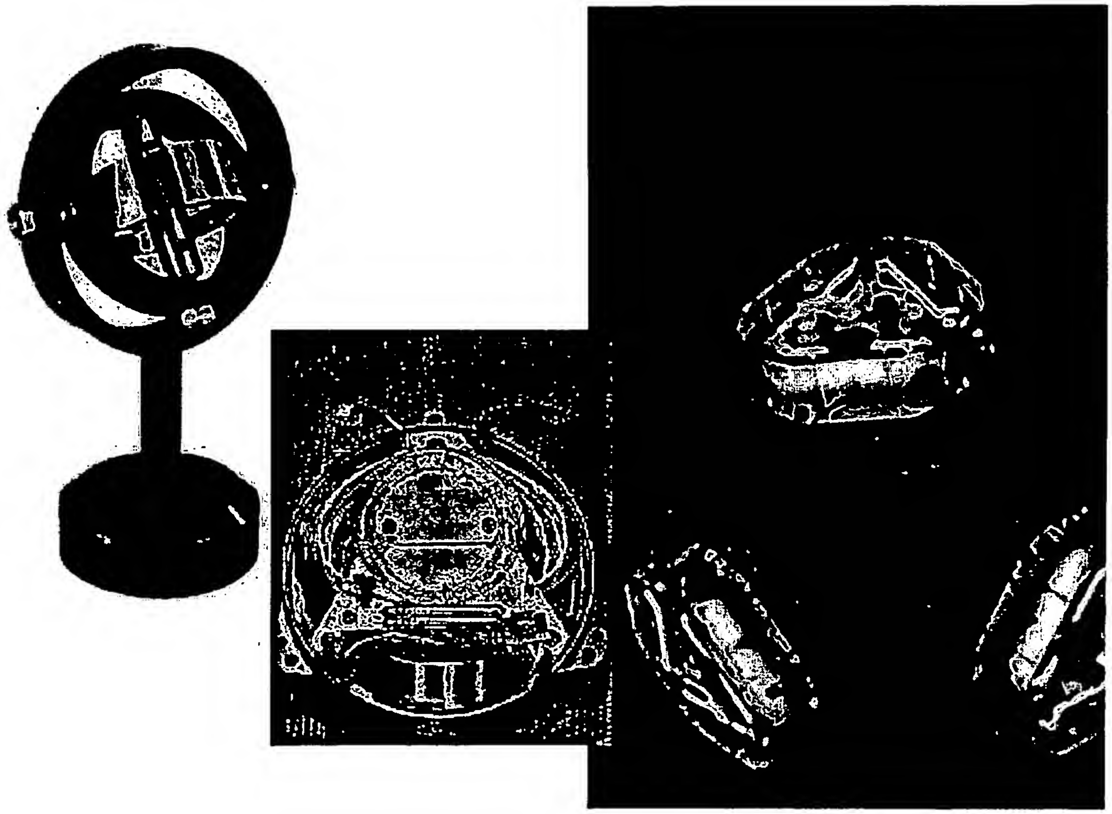
This method is also sometimes called "track via missile" (TVM) since the missile acts as a conduit of tracking information from the target back to the ground control station. The advantage of TVM homing is that most of the expensive tracking and processing hardware is located on the ground where it can be reused for future missile launches rather than be destroyed. Unfortunately, the method also requires excellent high-speed communication links between the missile and control station, limiting the system to rather short ranges. Retransmission homing guidance is used on the Patriot surface-to-air missile.

NAVIGATION GUIDANCE

Like homing guidance, navigation guidance includes several subcategories. In this section, we will describe inertial, ranging, celestial, and geophysical navigation techniques.

Inertial Navigation Guidance

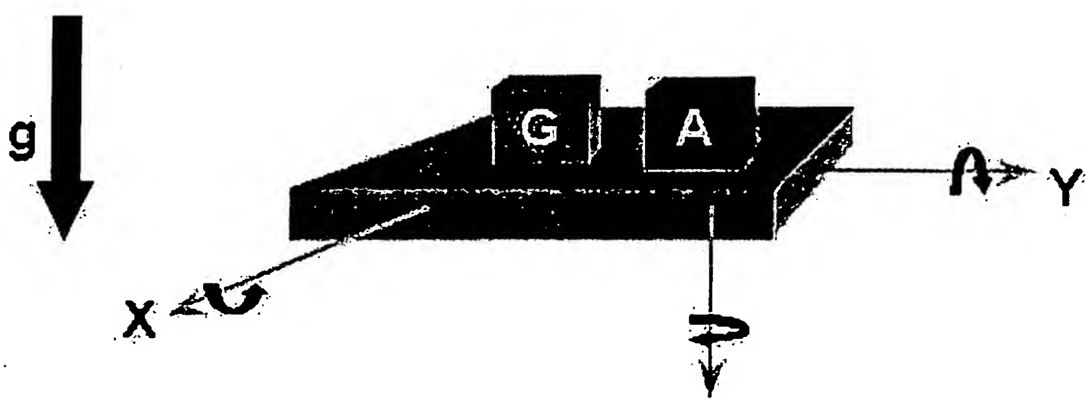
Inertial navigation relies on devices onboard the missile that sense its motion and acceleration in different directions. These devices are called gyroscopes and accelerometers.



Mechanical, fiber optic, and ring laser gyroscopes

The purpose of a gyroscope is to measure angular rotation, and a number of different methods to do so have been devised. A classic mechanical gyroscope senses the stability of a mass rotating on gimbals. More recent ring laser gyros and fiber optic gyros are based on the interference between laser beams. Current advances in Micro-Electro-Mechanical Systems (MEMS) offer the potential to develop gyroscopes that are very small and inexpensive.

While gyroscopes measure angular motion, accelerometers measure linear motion. The accelerations from these devices are translated into electrical signals for processing by the missile computer autopilot. When a gyroscope and an accelerometer are combined into a single device along with a control mechanism, it is called an inertial measurement unit (IMU) or inertial navigation system (INS).

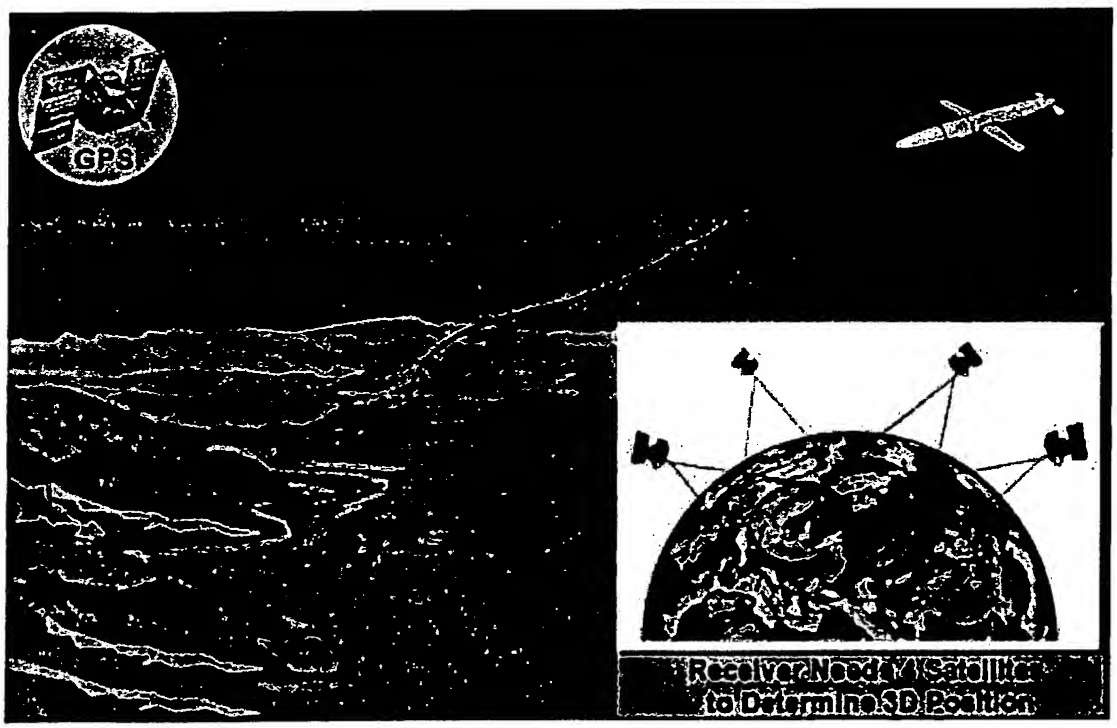


Inertial navigation concept

The INS uses these two devices to sense motion relative to a point of origin. Inertial navigation works by telling the missile where it is at the time of launch and how it should move in terms of both distance and rotation over the course of its flight. The missile computer uses signals from the INS to measure these motions and insure that the missile travels along its proper programmed path. Inertial navigation systems are widely used on all kinds of aerospace vehicles, including weapons, military aircraft, commercial airliners, and spacecraft. Many missiles use inertial methods for midcourse guidance, including AMRAAM, Storm Shadow, Meteor, and Tomahawk.

Ranging Navigation Guidance

Unlike inertial navigation, which is contained entirely onboard the vehicle, ranging navigation depends on external signals for guidance. The earliest form of such navigation was the use of radio beacons developed primarily for commercial air service. These beacons transmit radio signals received by an aircraft in flight. Based on the direction and strength of the signals, the plane can calculate its location relative to the beacons and navigate its way through the signals.



Global Positioning System used in ranging navigation guidance

The advent of the global positions system (GPS) has largely replaced radio beacons in both military and civilian use. GPS consists of a constellation of 24 satellites in geosynchronous orbit around the Earth. If a GPS receiver on the surface of the Earth can receive signals from at least four of these satellites, it can calculate an exact three-dimensional position with great accuracy. Missiles like JSOW and the JDAM series of guided bombs make use of GPS signals to determine where they are with respect to the locations of their targets. Over the course of its flight, the weapon uses this information to send commands to control surfaces and adjust its trajectory.

Celestial Navigation Guidance

Celestial navigation is one of the earliest forms of navigation devised by humans. and it saw its greatest application in the voyages of the great maritime explorers like Christopher Columbus. Celestial navigation uses the positions of the stars to determine location, especially latitude, on the surface of the Earth. This form of navigation requires good visibility of the stars, so it is only useful at night or at very high altitude. As a result, celestial navigation is seldom applied to missiles, though it has been used on many ballistic missiles like Poseidon. The missile compares the positions of the stars to an image stored in memory to determine its flight path.

Geophysical Navigation Guidance

Perhaps even older than celestial navigation is geophysical navigation, which relies on measurements of the Earth for navigation information. Methods that fall under this category include the use of compasses and magnetometers to measure the Earth's magnetic field as well as gravitometers to measure the Earth's gravitational field.

While these methods have not found much application in missiles, a more useful technique is terrain matching. This method typically requires a radar altimeter that uses radar waves to determine height above the ground. By comparing the contours of the terrain against data stored aboard the missile, the autopilot can navigate its way to a particular location.

A related but more accurate technique is called digital scene matching. In concept, digital scene matching is little different than looking out the window of your car and using landmarks to navigate your way to a specific location. Missiles make use of this technique by comparing the image seen below the weapon to satellite or aerial photos stored in the missile computer. If the scenes do not match, the computer sends commands to control surfaces to adjust the missile's course until the images agree. Digital scene matching is used on the Tomahwak cruise missile.

Summary

As discussed earlier, a missile may use one particular form of guidance throughout its flight or it may depend on different types of guidance at different times. The following tables compare the midcourse and terminal guidance methods used on a variety of weapons.

Missile	Launch/Terminal	Mission	Guidance Type		Sensor Type
			Midcourse	*Terminal*	
Nike Hercules	Surf-to-Air	Anti-Air	Command Guided	Command Guided	None
Terrier	Surf-to-Air	Anti-Air	Beam Rider	Beam Rider	None
Sidewinder	Air-to-Air	Anti-Air	Passive	Passive	IR
Sparrow	Air-to-Air	Anti-Air	Semi-Active	Semi-Active	RF
Shrike	Air-to-Surface	Anti-Radar	Inertial	Passive	RF
Agile	Air-to-Air	Anti-Air	Passive	Passive	IR
Standard Missile	Surf-to-Air	Anti-Air	Command Guided	Semi-Active	RF
Hawk	Surf-to-Air	Anti-Air	Semi-Active	Semi-Active	RF
Phoenix	Air-to-Air	Anti-Air	Inertial/ Semi-Active	Semi-Active/ Active	RF
Harm	Air-to-Surface	Anti-Radar	Passive	Passive	RF

Missile	Launch/Terminal	Mission	Guidance Type		Sensor Type
			Midcourse	*Terminal*	
ASROC	Surf-to-Surface	Anti-Submarine	Inertial	Active	Sonar
Walleye	Air-to-Surface	Anti-Surface	Passive	Passive	EO
Maverick	Air-to-Surface	Anti-Surface	Passive	Passive	EO
Maverick	Air-to-Surface	Anti-Surface	Passive	Passive	IR
Maverick	Air-to-Surface	Anti-Surface	Semi-Active Laser	Semi-Active Laser	IR
Tomahawk (TASM)	Surf-to-Surface	Anti-Ship	Inertial/GPS Scene Match	Active & Passive RF	RF
Tomahawk	Surf-to-Surface	Anti-Surface	Inertial	Passive	EO
Harpoon	Air/Ship/Sub-to-Surface	Anti-Ship	Inertial	Active	RF
Penguin	Air/Ship-to-Surface	Anti-Ship	Inertial	Passive	IR

Missile	Launch/Terminal	Mission	Guidance Type		Sensor Type
			Midcourse	Terminal	
Stinger	Surf-to-Air	Anti-Air	Passive	Passive	IR
RAM	Surf-to-Air	Anti-Air	Passive RF	Passive IR	RF & IR
Patriot	Surf-to-Air	Anti-Air	Command	TVM	RF
SLAM	Air-to-Surface	Anti-Surface	GPS Aided Inertial	Passive	IR
AMRAAM	Air-to-Air	Anti-Air	Inertial	Active	RF
JSOW	Air-to-Surface	Anti-Surface	GPS Aided Inertial	GPS Aided Inertial	Inertial
JDAM	Air-to-Surface	Anti-Surface	GPS Aided Inertial	GPS Aided Inertial	Inertial
Bat	Air-to-Surface	Anti-Surface	Inertial	Passive Acoustic/IR	Inertial Acoustic/IR
Hellfire	Air-to-Surface	Anti-Surface	Inertial	Semi-Active Laser	IR
Hellfire	Air-to-Surface	Anti-Surface	Inertial	Active	mmW RF

Note that many weapons also make use of a combination of methods simultaneously. In particular, a common technique is a combined GPS/INS system that takes advantage of both inertial and ranging guidance to improve accuracy.
- answer by Jeff Scott, 1 August 2004

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